

SOME CANADIAN IRON ORES.

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(Read at the Troy Meeting, October, 1883.)

THE iron ores of Canada have attracted more or less attention in this country for a number of years ; and having had an opportunity this past summer to examine some of them, especially the magnetic ores, I have thought it might be of sufficient interest to the members of the Institute to put on record some of my observations.

The region examined contains, for the most part, only the rocks of the Laurentian system. Much of it was originally covered with a dense growth of pine, which interfered with successful prospecting for ores. However, after the best of the timber had been cut off, fire generally got into the bush and cleared it up pretty well. This, besides making travelling about easier, exposed large surfaces of rock, and rendered the work of the prospector far more liable to be rewarded with success, while removing many of its hardships. The general appearance and productiveness of the land have, however, been far from improved by this process. It would be difficult to find a more desolate-appearing country than some of these pine woods after fire has been through them.

The country examined may be, for convenience, divided into two sections: the one in Ottawa and Pontiac counties, in the province of Quebec, beginning at the Haycock location, northwest of Ottawa, and continuing up the Ottawa River to the Ade location, in the township of Bristol ; and the other south of the Ottawa River, and east of the Kingston and Pembroke Railway, in the counties of Lanark, Leeds, and Frontenac, in the province of Ontario.

THE HAYCOCK MINE.

This mine is located in the northeast portion of the township of Templeton, about eight miles east of the Gatteneau River, and about twelve miles from the City of Ottawa. The occurrence of the ore is very remarkable. The ore consists of hematite, with a considerable amount of magnetite, and is remarkably pure. It is very hard and compact, showing, in some cases, distinct cleavage ; but most of it occurs in lumps, from the size of a walnut up to a few cubic yards, scattered through the rock, which is a very

coarsely crystalline aggregate of a pinkish felspar and quartz, with rarely a small amount of hornblende, and this mostly in association with the felspar. One especially curious feature was aptly described by my guide, who said, "It looked as if a ladle full of molten ore had been dashed down upon the surface of the rock." There is more or less apparent parallelism in the occurrence of the ore-bodies, but there were few indications of a well-defined and permanent deposit.

There was one good-sized opening, besides a number of small pits, from which perhaps 2000 tons of ore had been extracted; but the mining must have been rather expensive, and from the small and isolated nature of the ore-bodies must be very uncertain. Notwithstanding this, a forge of four fires had been built in which some very good blooms were made, and four large charcoal kilns had been built, also a tramway to the old furnace at Hull. All these works, however, have been out of use for several years, and are rapidly going to decay. The composition of the ore in selected samples is given by the following analyses from the *Canadian Geological Survey*.*

Fe ₂ O ₃ ,	88.08	89.80	85.45
FeO,	6.86	7.06	5.24
MnO,	0.24	trace	0.15
CaO,	0.55	trace	0.41
MgO,	0.13	0.22	0.17
P ₂ O ₅ ,	0.16	trace	0.13
S,	0.03	trace	0.07
TiO ₂ ,	3.17	2.34	2.12
C,	0.35	0.43	0.28
Insoluble,	0.26	0.11	5.77
	99.83	99.96	99.79
Fe,	66.98	68.34	63.88

Analyst, Professor E. J. Chapman.

THE HULL MINES.

Iron ore has been mined at Hull, Quebec, with varying degrees of activity, for more than twenty-five years, the product having been between sixty and seventy thousand tons. At the time of my visit work had been temporarily suspended, awaiting the completion of the Gatteneau River Railway, which will pass within a short distance of the Forsythe mine, so that the principal shaft was full of water, and no direct observations could be made underground. The ore occurred in a series of outcrops in a general east and west

* 22d Rep. of Prog. Can. Geol. Sur., 1873-74, p. 226.

direction. Many of these outcrops were small, and had been worked out after having produced a few hundred tons of ore. The principal mine, the Forsythe or Old Ironsides, has produced about 60,000 tons, and is said to have considerable ore yet in sight in the lower workings. On the surface it showed a width of 15 to 35 feet in a cut 100 feet long. The occurrence of the ore here is also peculiar, being entirely in a very impure limestone, the latter being associated with a hornblende gneiss. The limestone is white and crystalline, and the principal impurities, which form a considerable portion of the whole mass, are a light green pyroxene, quartz and graphite. The ore is of two kinds, the black magnetite ore and the so-called red ore, which is a mixture of magnetite and hematite. It is hard and compact, with imperfect cleavage, and generally shows a considerable number of flakes of graphite on a fresh fracture. Cavities showing well-crystallized calcite are also common. This ore, besides being shipped to the United States, was smelted in the old charcoal furnaces at Hull* (size 38 by 10½), and produced some excellent iron. The composition of the charge was very poorly calculated, for besides limestone, considerable amounts of clay and siliceous sand were used, which were entirely unnecessary, not only decreasing the capacity of the furnaces, but also increasing the consumption of charcoal, which was excessive, being 235 bushels per ton. The following analyses were taken from the *Canadian Geological Survey Report*.†

	Red Ore.	Black Ore.	Black Ore (picked specimens).
	I.	II.	III.
Fe ₂ O ₃ , . . .	66.20	} 73.90	} 93.82
FeO, . . .	17.78		
Mn, . . .	trace	none	0.12
Al ₂ O ₃, . . .	.....	0.61	0.79
CaO, . . .	1.85	.....	0.45
MgO, . . .	0.18	1.88	0.94
P, . . .	0.015	0.027	0.08
S, . . .	0.28	0.085	0.11
CO ₂ , . . .	1.17	.....	.....
SiO ₂ , . . .	11.11	20.27	3.75
TiO ₂ , . . .	none	none	.....
Graphite, . . .	0.71	.....	.....
H ₂ O, . . .	.....	3.27	.....
	99.295	100.042	100.06
Fe, . . .	60.17	53.51	67.94
Analysts, . . .	Dr. T. S. Hunt.	Dr. T. S. Hunt.	Prof. C. F. Chandler.

* Dr. T. S. Hunt, 18th Rep. of Prog. of Can. Geol. Sur., 1866-67.

† 22d Rep. of Prog. Can. Geol. Sur., 1873-74, p. 211.

there has been no recent work, all of them at some distance from the Kingston and Pembroke Railway; and the mines in active operation directly on the line of the railway. The former were made upon the outcrops of small bodies of ore, and were worked crudely and intermittently. The ore was generally mined and taken away in winter, when hauling is cheap. In several cases a few hundred tons of ore exhausted the opening, and a new one was started close by, but in no place were there any indications of a large or permanent deposit of ore, and in no case was the mining carried to any great depth. The openings on the shores of Christie's Lake, in South Sherbrooke, offer a most desirable location for large and active mining operations, being on a considerable cliff with steep sides, affording easy access and abundant dumping-ground. But the amount of ore seems to be limited; and the locality is chiefly interesting for the variety of minerals thrown out, amongst which may be mentioned pyroxene, scapolite, sphene, a pink calcite, and an occasional crystal apatite. The rock is a hornblendic gneiss of a curiously banded structure, due to the accumulation of hornblende in certain narrow layers. The ore is coarsely crystallized, coarse octahedrons being quite common, or compactly massive, with octahedral cleavage, well developed, and is of the following composition:*

Fe ₃ O ₄	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	90.61
TiO ₂	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2.83
P ₂ O ₅	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.05
Fe	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	65.62

Analyst, Dr. B. J. Harrington.

From the Fournier openings in South Sherbrooke a considerable amount of ore has been taken, one of the openings being 100 feet deep. The ore-body is in the same hornblendic gneiss, and consists of tough hornblende rock with the ore, which is very hard and compact, showing indistinct cleavage and an occasional seam of pyrite. The percentage of iron, as determined by Dr. Harrington, is 59.55.

From the Bygrove mine, also in South Sherbrooke, at the foot of Bob's Lake, a considerable amount of interesting mineralogical material was taken, but the ore appeared to be scattered in small veins through the rock, the whole mass not being very rich. Among the minerals observed may be mentioned hornblende, pyroxene, scapolite, pink calcite, and cupriferous pyrite. The percentage of iron, as determined by Dr. Harrington, is 59.59.

* 22d Rep. of Progress Can. Geol. Sur., 1873-74, p. 210.

On the very edge of Spectacle Lake, in North Crosby, near Westport, an opening 12 feet deep had been made. From this a considerable amount of a fair ore containing cupriferous pyrite had been taken, and from an adjoining lot more of the same kind had been extracted.

The mines in active operation are in the immediate vicinity of the Kingston and Pembroke Railway. There is great similarity in the occurrence of the ore; and a few words, by way of general introduction, will apply to all.

The ores in general are fine-grained, hard, and compact; consist of magnetite in intimate association with more or less hornblende and chloritic material, and frequently show a banded appearance. They also contain considerable calcite and dolomite, finely disseminated and in bunches. The only apparent difference in different localities is the presence of more pyrite in some than in others.

The veins vary in thickness from a few feet up to 40, with a general northeast and southwest strike, and a 25 to 40 degrees dip to the southeast. The walls are very persistent, being the same with one exception in every case, the formation being the Laurentian. The foot-wall is a white, moderately crystalline limestone, with a considerable percentage of magnesia; it also contains considerable white, crystalline, glassy quartz; a silver-white mica, and an occasional speck of graphite. It is very uneven, rising and falling frequently, with a wavy surface, which accounts for much of the variation in the thickness of the veins.

The hanging-wall presents many variations in texture, tint, and the ratio of its different constituents, but it is always a reddish or dark hornblende gneiss. It varies in texture from a coarsely crystalline rock, in which the different minerals can be readily distinguished microscopically, and in which an occasional seam shows well-formed crystals, to a very fine-grained and compact rock. The prevailing color is red, but there are many shades; and some of the very fine-grained specimens, especially those containing considerable hornblende, are dark, sometimes almost black. The proportion of hornblende varies from an occasional flake in the coarse and very red varieties to a considerable amount in the fine-grained and dark varieties. The visible accessory minerals are epidote, and an occasional speck of pyrite. It is a moderately strong and tenacious rock, and, when undisturbed, in the finer-grained varieties, especially, makes a fairly good roof.

THE CALABOGIE LAKE MINES.

The northernmost openings of this series are near Calabogie Lake, in the township of Bagot. Beginning at the opening farthest from the lake, the Calabogie Iron Company had gone down about 40 feet, and were preparing to put up hoisting machinery. The strata are decomposed to a considerable depth, and are very much disturbed from a cross-dyke, and the work had not progressed far enough to make out the relationships exactly. The ore presents a variety of aspects, being also influenced by the cross-dyke. Some of it is fine-grained and granular, some compact, some showing a banded structure. As mined it will average about 50 per cent. of iron, and contains considerable calcite, and also some cupriferous pyrite.

The same company has another small opening on the land of Mr. Thomas Church, from which a small amount of material had been taken and then the work stopped.

Between these two openings Mr. Coe had just commenced work on a vein showing about eight feet of ore at the surface, with a dip of about 30 degrees. The ore is very hard and compact with some traces of cleavage. It contains some pyrite and calcite (both crystallized, and a pink cleavable variety), and also some amethyst.

The fourth and last opening has been made by the Calabogie Iron Company on the very shores of the lake, in Grassy Cove. This opening shows a well-defined vein with both walls, and was down about 60 feet upon the dip, which is about 25 degrees towards the south, the strike here approaching east and west. About 2000 tons of ore had been taken out and boated across Grassy Cove to the railway, which will not be finished across the cove for some time on account of a heavy fill. The ore is fine-grained and granular, much of it being very distinctly stratified, and some of the strata being cupriferous pyrite, of which the ore carries a considerable amount. Among the associated minerals may be especially mentioned the occurrence of prehnite in curious worm-like forms, showing a stellate arrangement of imperfect crystals upon a cross-fracture. The following analyses represent the composition of the various ores from the openings of the Calabogie Iron Company. I am indebted for them to Mr. Edward Elliott, President of the Calabogie Iron Company, of Perth, Ontario :

No. 1.—NEAR LAKE.

Fe ₂ O ₃ , . . .	44.59	....	....	....	....
FeO, . . .	35.83	....	....	....	....
SiO ₂ , . . .	4.28	5.53	4.44	3.24	....
TiO ₂ , . . .	0.60	....	....	....	....
P, . . .	0.028	0.012	0.018	0.025	0.18
S, . . .	0.38	....	....	....	....
Fe, . . .	59.76	61.48	65.15	62.23	63.619
Analysts, .	Mr. Emerton.	Mr. Charles E. Wright.	Dr. Fricke.		

No. 2.—CHURCH'S LOT.

Fe,	52.326
P,	0.190

Analyst, Dr. Fricke.

No. 3.—FARTHEST FROM LAKE.

Fe ₂ O ₃ ,	58.98	....
FeO,	22.35	....
SiO ₂ ,	4.35	....
TiO ₂ ,	0.40	....
P,	0.203	0.143
S,	0.10	63.62
Fe,	58.67	....

Analysts, . . . Mr. Emerton. Dr. Fricke.

THE RADDENHURST & SHERRITT AND W. C. CALDWELL MINES.

About twelve miles south of the Calabogie Lake mines is the Raddenhurst & Sherritt mine, near Round Lake. The main shaft was down about 68 feet, showing the same walls, and northeast and southwest strike, but with only a very small dip, not over ten degrees to the southeast. The hanging-wall here was the darkest observed anywhere. Some of the smaller openings seemed to indicate the presence of a cross-vein, but its existence was not fully established. Most of the ore is compact and stratified, some of the strata being a cupriferous pyrite, which forms a considerable percentage of the ore; and it is very prone to decompose, so much so that upon exposure for a short time to the atmosphere many lumps crumble to a coarse powder. Some of the ore is compact, crystalline, and cleavable, and contains dolomite scattered through it.

About one-half a mile south of this Mr. W. C. Caldwell had put down a shaft which was idle and full of water. The ore and general appearance seemed to be the same as the foregoing.

THE BETHLEHEM AND B. CALDWELL MINES.

About twelve miles south of the last location is the scene of the most active mining operations of the whole region. The presence of magnetite at this point has been known for many years, from the difficulty experienced in the use of the compass by the land-surveyor when the country was first plotted. This fact being known to Mr. Boyd Caldwell, an extensive lumber dealer, he not only purchased the timber from the government, but also took out a patent for the land. The question of the ore remained dormant, however, for many years, on account of the inaccessibility of the country, until there was a prospect of rail-communication by the construction of the Kingston and Pembroke Railway. Work upon the development of the ore was first undertaken by Mr. Caldwell in January, 1880, and carried forward until the presence of a large body of ore was clearly established, when, in July, 1881, a portion of the land was leased to the Bethlehem Iron Company, which has carried on active mining operations ever since. At the time of my visit about seventy men were employed in the principal mine, which was down about 250 feet, the product being 100 tons per day of a good 50 per cent. Bessemer ore, the total product having been about 30,000 tons.

On the adjoining lot, Mr. Caldwell was working one drill and a small force of men upon the same vein. He has gone down 200 feet; but his work is entirely developmental, and he has not attempted to carry on regular mining operations.

The general characters of the vein, as exhibited in both shafts, are the same. The vein strikes northeast and southwest, approaching, however, to the north, and dips 30 to 35 degrees to the southeast. The walls are very persistent, with well-defined selvages. The thickness of the vein varies from two to thirty-one feet, due principally to the rolling of the limestone foot-wall, which is excessive. The ore is compact, crystalline, and cleavable magnetite, mixed with a large amount of chloritic material, which occasionally, although not always, gives a stratified appearance to the ore. There is very little visible pyrite in the ore, but it contains a considerable amount of carbonates of the alkaline earths, varying in composition from a nearly pure calcite through a true dolomite to magnesite, containing a considerable percentage of carbonate of lime. The dolomite sometimes occurs in large masses, near which the ore is generally very much richer, as if the dolomite ordinarily scattered through the ore had been gathered into one mass by itself, which

would necessarily enrich the ore from which it had been withdrawn, while some of the calcite occurs in small veins, with a beautifully fibrous structure.

Among the minerals at this locality may be especially mentioned a coarse, gray asbestos and a green chlorite in good-sized cleavable foliæ.

The ore is shipped to the works of the company, at Bethlehem, Pennsylvania, and the composition is represented by the following analyses :

Fe,	. 63.730	58.49	Fe ₃ O ₄ ,	89.04
SiO ₂ ,	. 4.466	9.15 (rock matter)		6.34
TiO ₂,	. ....	....		....
CO ₂,	. ....	....		1.97
Al ₂ O ₃,	. ....	0.28		0.38
Mn,	. ....	1.79		trace
CaO,	. ....	3.32		1.15
MgO,	. ....	5.66		1.06
P,	. 0.028	P ₂ O ₅ , 0.071		traces
S,	. 0.032	0.12	SO ₃ ,	traces
Analysts, Rhodes & Co.		Mr. E. M. Reed.	Prof. E. J. Chapman.	

THE ROBERTS MINES.

About ten miles south of the last mines, in the township of Palmerston, are the Roberts mines. The ore occurs here in isolated lenses, and the mining has been very uncertain. At the time of my visit the ground was being very thoroughly prospected with a diamond drill in the hope of removing at least a part of the uncertainty, and some very good-looking cores had been obtained. The use of the needle here is very deceptive, as the rocks are full of small veins and strings of magnetite, which give strong attractions over a wide surface. The principal shaft, the Lizzie, had gone down 180 feet on the dip, and produced about 60,000 tons of excellent ore; but at this point the ore had been sharply and completely cut off. The method of this cutting-off was peculiar, and I had not sufficient time to explore it thoroughly; the rock beyond is the hanging-wall, but with a large increase in the amount of hornblende, with the size of the particles of each mineral approaching uniformity; This would lead to the supposition that the worked-out ore-body had risen upward as the result of a fault; but if so, it was a peculiar fault, since all signs of violent disturbance at the juncture of the ore and rock are wanting. The line of demarkation between the two is very distinct, but the continuity is scarcely broken.

Another explanation of the phenomena may be that the deposit

of ore was a pocket in the rock and had been worked out, but it had well-defined and regular walls similar to the other veins, a limestone foot-wall and hornblendic gneiss hanging-wall, also the regular dip and strike of the other veins. It would be necessary to spend considerable time, and probably considerable more mining would have to be done, to thoroughly work out the causes of this cut-off.

The ore was coarsely crystalline, cleavable, and rich. There was but little visible pyrite; but associated with the ore was a handsome pink crystalline calcite, carrying cupriferous pyrite; the hanging-wall at this point showed a large amount of epidote and also graduated at times into a typical gray gneiss.

From the Mary shaft, just north of the Lizzie, about 20,000 tons of a fine-grained granular ore, very different from the Lizzie ore, had been taken out to the depth of 40 feet, and then mining was suspended.

Besides the above principal openings, several prospecting openings were being developed to ascertain what the surface shows, which in some cases were very good, would lead to. Although the full working force was 80 men, only 20 were at work with the diamond drill and performing the prospecting work. The ore was shipped to Elmira and Charlotte for smelting, and its composition is shown by the following analyses, for which I am indebted to Mr. B. W. Folger, of Kingston, Ontario:

Fe,		57.77	63.2
O,	. . . . .	....	24.7
SiO ₂ ,		15.10	6.8
Al ₂ O ₃ ,		0.29	undetermined.
CaO,		6.38	1.8
MgO,		2.47	....
Mn,		0.40	traces
P ₂ O ₅ ,		0.025	....
S,		0.08	0.2
CO ₂,	. . . . .	....	1.5
TiO ₂,	. . . . .	....	trace,

Analysts, . . . Mr. E. M. Reed. Mr. J. B. Britton.

THE GLENDOWER MINES.

The last mines of which I shall speak are the Glendower mines, about four miles from Bedford Station, and twenty-one miles south of the Roberts mines, on the shore of Thirty Island Lake. An opening very near the lake presents the single exception mentioned in regard to the walls. An upthrow here has apparently transposed the lime-

stone foot-wall into the hanging-wall. There is also cutting across the ore a small dyke, eight inches thick, of typical gray gneiss. The shaft, which was down about 100 feet, was following along this cross-dyke. Work was begun in May, 1883, and sufficient work had not been done to fully settle the relationships. About 4000 tons of ore had been extracted. It is very hard, compact, and cleavable. Associated with the ore, both in small veins, and in bunches, is a variety of carbonates of the alkaline earths, varying in composition as at the Bethlehem mines; but the analyses showed, in some cases, such an excess of magnesia as to indicate that a considerable amount of magnesite must be mixed with some of the dolomite, although every one of six specimens of the carbonates which I examined showed an amount of lime sufficient to be precipitated by sulphuric acid in moderately concentrated solutions. In one case the carbonate was undergoing decomposition into a silicated material looking a little like serpentine. Occurring in a very similar manner to the carbonates is a white cleavable felspar. Serpentine is quite abundant in some portions of the ore, and there is also some visible pyrite.

To the west of this opening, a second shaft was being sunk, which, after passing through about 90 feet of a mixture of hornblendic material, and magnetite too low in iron to be considered available ore, passed through about 12 inches of a cleavable calcite, carrying pyrite, chalcopyrite, and mispickel in large amounts. After passing through this layer, good, hard, and cleavable ore like that in the other shaft had been found, and at the time of my visit there were about 20 feet in it without any change.

About 2000 tons of the ore have been shipped to Zanesville, Ohio, the composition of which is represented by the following analyses, for which I am indebted to Mr. B. W. Folger, of Kingston, Ontario.

Fe, . .	62.32	63.80	60.96	63.01	64.89	61.39
SiO ₂ , .	10.67	8.30	7.27	9.04	6.26	6.61
Mn, . .	0.51	0.47	0.80	0.61	0.48	0.61
Al ₂ O ₃, .	....	....	0.50	0.62	0.55	0.75
S, . . .	0.39	0.12	0.071	0.42	0.22	0.23
TiO ₂, .	....	....	traces	trace	trace	trace
CaO, . .	0.64	0.09	1.86	0.34	0.48	0.50
MgO, . .	0.98	4.01	3.88	4.49	2.04	5.29
P, . . .	0.01	0.011	0.012	0.020	0.013	0.012

Analyst, E. M. Reed, E. M. Reed, E. M. Reed, E. M. Reed,
June 14, '83. June 25, '83. Oct. 9, '82. Nov. 1, '82.

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